Understanding Mobile Information Needs on a Large-Scale: Tools, Experiences and Challenges

Karen Church, Mauro Cherubini, Joachim Neumann, Nuria Oliver
Telefonica Research
Torre Telefonica - Diagonal 00, Pl. Ernest Lluch i Marti 5,08019 Barcelona, Spain
karen@tid.es, mauro@tid.es, joachim@tid.es, nuriao@tid.es

ABSTRACT
It is well known that the types of information needs that arise while mobile differ significantly from the types of information needs that arise in desktop environments. Limited devices and interactions as well as dynamically changing contexts all have a role to play. However, to date, studies exploring mobile information needs have be relatively small in terms of scale and duration. The goal of this work is to understand more about mobile information needs on a larger-scale. In this paper we outline a study that employs intelligent experience sampling, an online diary and SMS technology as a means to gather insights into the types of needs that occur while mobile. Rather than reporting results, we discuss our experiences, the lessons learned and the challenges faced in terms of deployment, interacting with our participants as well as in analyzing the dataset we generated.

Author Keywords
Mobile needs, mobile user experience, SMS, experience sampling, user behaviour, context, diary study

ACM Classification Keywords
H.m Information Systems: Miscellaneous.

General Terms
Design, Experimentation, Human Factors

INTRODUCTION
Mobile phones are starting to dominate as the primary mode of accessing the Internet while on-the-move. This growth in popularity is due to a number of factors including: improved mobile broadband and mobile networks, the growing popularity of social networking, video services and VOIP services, as well as significant advances in mobile handset technology[1]. In the past two years, there has been a flurry of reports showcasing this growth. For example, a 2009 report by Morgan Stanley highlighted that the mobile Internet is growing faster than the desktop Internet ever did[2]. A study published by Nielsen in 2010 shows that mobile Internet usage is increasing significantly, in particular among young people[3]. Furthermore, according to a report by Deloitte in 2011, more than 50% of computing devices sold globally will be smartphones, tablets and non-PC netbooks, thus breaking the long-held market dominance of PC's[4].

Mobile users require applications and services that are tailored to their unique requirements and contexts. It is well known that the types of information needs that arise while mobile differ significantly from the types of needs that arise in desktop environments [9, 3]. Limited devices and interactions as well as dynamically changing contexts all have a role to play. There have been a number of studies that explore mobile information needs and the impact of context on those needs, however, the majority of these studies are relatively small in terms of scale and duration. The goal of this work is to understand more about the information needs that mobile users have while on-the-go on a larger-scale. Specially we want to understand (1) the types of needs that arise while users are on-the-move and (2) what proportion of those needs can be answered by other people (i.e. friends, family, etc) compared to what proportion can be answered by existing mobile services (e.g. Google local search). To this end, we carried out a large-scale study of mobile users which employs SMS, an intelligent experience sampling algorithm and an online diary tool to gain insights into the types of needs that arise while mobile. The study ran for for a period of 3 months, involved over 100 users and resulted in almost 12,000 SMS messages. In this paper we describe our methodology and the tools we developed, we discuss our experiences during the deployment and the challenges we faced both during the study and in analyzing and understanding the dataset we have gathered.

RELATED WORK
In the context of this research, there are two strands of related work: (1) user-centric approaches to understanding mobile information needs, many of which have relied on diary study methodology and (2) approaches to contextual experience sampling in mobile environments.

[1]Admob, "Mobile Metrics Report", 2010 See: http://bit.ly/b7DYFJ, last accessed Jun 2011

[2]Morgan Stanley, "The Mobile Internet Report", 2009 See, http://bit.ly/4JJDq4, last accessed Jun 2011

[3]Nielsen, "Mobile Youth Around The World", 2010 See, http://bit.ly/fzmCPK, last accessed Jun 2011

[4]Deloitte, "Technology Predictions 2011", 2011 See, http://bit.ly/fesYLW, last accessed Jun 2011

Large'11, September 18, 2011, Beijing, China.

Understanding Mobile Information Needs

There have been a number of recent studies focusing on user-centric approaches to understanding the nature of mobile information needs. Sohn *et al.* [9] conducted a diary study of how and why information needs arise when the user is on the go. They focused on the contextual factors that prompted each need and influenced how it was addressed. Participants indicated that 72% of their reported information needs were prompted by some contextual factor. According to the authors, the contextual prompting can be classified in four broad categories: *Activity*, *Location*, *Time*, and *Conversation*. Conversation is any phone or in-person conversation the participant was involved in at the time the need arose. In the same year, Dearman *et al.* [4] published the results of a 4-weeks diary study on how information needs can be supported by individuals in the social network. They found that the timeliness of the message and the trust relationship with the source of the answer were variables that participants took into account to evaluate the usefulness of the received information. While these studies recruited average users, Heimonen [6] conducted a study with active mobile internet users and found an increased number of situations in which mobile information needs were addressed using mobile devices. These findings were later on extended by the work of Church & Smith [3] that focused on the actual goals behind the needs. Needs can represent intermediate states to achieve more complex goals. Interestingly, they found that the majority of entries (67%) were generated when users were away from their familiar contexts. Similarly, contexts like location, time, activity and social interactions have an effect on the type of needs that arise while mobile.

The studies reported above were conducted in a short timeframe and with a relatively small sample. To the best of our knowledge the most complete study of mobile information needs is the work of Dearman and colleagues [4]. However, even in this case, the study lasted only four weeks and involved 20 participants. One of the methodological limitations of diary studies is that they require a considerable effort from participants to 1) carry the diary material around; 2) setup the material when an entry has to be created; 3) record the details of the entry. This is one of the reason why in the best case diary entries of mobile needs produced dataset of relatively small size (e.g., in the case of the Dearman study, they collected around 1.2K entries). In the effort of lowering the burden of carrying out diary studies, Brandt et al. [1] looked at how to use SMS to quickly capture the essence of the situation when the user is on the go and then later complement these fragments with more complete information inputed through a web browser. Our work builds upon this endeavor by adding some intelligence behind how and when we capture these fragments of experience when the user is on the go.

Contextual Experience Sampling

Experience Sampling (more formally known as the Experience Sampling Method, or ESM) is a research method that involves asking participants to report on their experiences with an application, service or something similar at specific points throughout the day. Often subjects are sampled at random points and over a longer period like a week or a month. Contextual experience sampling methods attempt to go one step further by only signaling users at appropriate times or in the right context. As Cherubini and Oliver highlighted in a previous paper [2], the main advantage of ESM is its ability to preserve the ecological validity of the measurements, defined by Hormuth [7] as: "the occurrence and distribution of stimulus variables in the natural or customary habitat of an individual". This method compares with recall-based self-reporting techniques –although recall delay is kept minimal– by "beeping" the subject in close temporal proximity to when a relevant event was produced. However and due to the level of involvement of each participant in the collection process, the method produces self-reported data. See Intille et al. [8] and Fisher [5] for some recent approaches to contextual experience sampling.

Additionally, the biggest advantage of using the ESM in research involving ubiquitous devices or applications lies in the ability to deploy user studies to large samples without the usual restrictions of device fragmentation. However, large samples imply a computational infrastructure to support the research team in deploying the stimuli and collecting the responses from the participants.

To facilitate this study we developed a contextual experience sampling framework that utilizes two-way SMS technology to learn more about mobile information needs. Users send details about their information needs via SMS, while users are periodically probed about their information needs, also via SMS. The framework is built around the concept of an *intelligent experience sampling algorithm* that relies on the profile and schedule of the end-user to ensure that participants are only asked about their information needs at the most appropriate times and in a non-intrusive manner. We combine the contextual experience sample with an online web diary tool in which users can provide more details/context about the information needs they expressed earlier in the day. In this way the SMS messages sent by the end-users act like a type of trigger, reminding users where they were at the time of the need, who there were with, etc. To our best knowledge this is the most comprehensive study of mobile information needs in terms of size, scope and methodology and as such we're excited about the insights into the information needs and information behaviours of mobile users our results are likely to yield. In the following section we describe the study methodology and following this we discuss the experiences and challenges we faced during the deployment and analysis phases of our study.

STUDY METHODOLOGY

In this section we outline the methodology we employed during our study of mobile information needs.

Participants

Our participants were recruited using a survey published via a major Web portal in Spain. In the survey, participants were asked a range of questions about their demographics and their mobile usage. We recruited 108 users, 66 male and 42 female who actively use SMS and who actively use the Internet either via a PC or via their mobile[5]. Participants ranged

[5]We started the study with over 200 users, however many users dropped out of the study either before it began or in the early stages

in age between 18-58, with an average age of 35 (min: 18, max: 58, standard deviation: 9.2). Our participants came from a diverse range of backgrounds including IT, engineering, administration, law, production, sales, and education. All of our participants lived in Spain and the vast majority were of Spanish nationality (all except 6 participants).

Procedure

The study ran for a period of 3 months from Jan-Apr 2011 and involved developing a complex framework that includes four key components:

1. **Scheduler**: Users were asked to access an interactive Web page we designed to provide details of their daily schedules and daily locations, that is to tell us about their daily routines. For example, when they are normally at home, at work, in the gym, asleep, etc. We provided users with a set of baseline locations/activities like at home, at work, school/college, gym, family time, etc. but users were also free to add up to 5 additional locations/activities. Along with telling us the times of day they were at this location or engaged in this activity, we also asked users to indicate whether they were willing to receive an SMS at these locations or during these activities. This scheduling information was used to inform an intelligent experience sampling algorithm we used to probe users about their mobile needs via SMS. Finally, users could also indicate times of the day or days of the week when they did not want to be disturbed with an SMS message.

2. **SMS Component**: Users were informed that they would receive at most 3 SMS messages per day, asking them about their information needs. Users were asked to respond to these SMS probes with relevant details of their information needs. We setup a free SMS short-code service for the duration of the study so that our participants were able to send SMS messages free of charge. Note that users were also free to send us an SMS detailing their information needs at any time of day, i.e. out of the scope of the SMS probes.

3. **Intelligent Experience Sampling Algorithm**: In order to ensure that users were only asked about their information needs at appropriate times, i.e. in a non-intrusive manner, we designed an intelligent experience sampling algorithm that utilized the scheduling data described earlier. The algorithm was designed to send a maximum of 3 SMS per day to each user and to send the SMS probes at different times throughout each day so that we could capture a range of data points and as such a range of insights in the types of needs that arise while mobile. The algorithm was invoked once an hour, every day, for the entire 3 month duration.

4. **Online diary**: Finally participants were asked to periodically clarify their information needs via an online Web diary. In terms of the online Web diary, participants were asked to provide additional details like: (1) where they were located at the time of the need?, (2) who they were with (friends, family, alone, etc.)?, (3) what they were doing?, (4) if they satisfied the information need? and (4) how they satisfied the information need? The diary tool was accessible from both mobile and desktop Web-browsers and was designed to capture the motivations and intent surrounding mobile information needs while minimizing the time burden on the participants. To achieve this balance the survey included a mix of open-ended questions as well as closed questions where the user made selections from a given set of possible answers.

Along with the SMS probes, we also sent a few emails throughout the study to keep users informed of the study. At the end of the study, each participant filled in a post-study questionnaire in which we asked more detailed questions about their mobile information needs and in particular how they satisfy those needs. In terms of incentives each user was given a gift voucher worth 30 euros. We also raffled 3 prizes among the participants as payment for participating worth 300, 200 and 100 euro respectively.

EXPERIENCES & CHALLENGES

Overall the study was a great success. It ran for the 3 month period and resulted in a rich dataset of almost 12,000 SMS messages. In this section we would like to focus our experiences and the challenges we faced while conducting this experiment.

Participant Recruitment and Interaction

Mobile user experience research is challenging for a variety of reasons. For example, capturing data in-the-wild and dealing with dynamically changing contexts, handling mobile devices and their limitations, designing and building innovative and intuitive mobile applications for a range of OSs, etc. However, a key challenging in mobile user experience research lies in participant recruitment and interaction. The majority of existing mobile user experience research carried out in the wild tends tends to utilize a relatively small group of users. This is particularly true for the related research on mobile information needs (most of which involve around 20 participants). And although interesting insights can be found, these small samples can impact on results. Our aim was to carry out a study on a larger-scale and as such we recruited over 100 users. This user size is by no means large nor can we consider it as a representative sample of the entire mobile population, however, we did go to great lengths to ensure diversity within our participants. Despite 100 users still being small in the grand scheme of things, we faced a number of challenges in recruiting these users and more importantly in interacting with these users throughout the study.

As with any longitudinal study we needed to maintain contact with our participants, to keep them informed of the study and their own progress. To help with this task we setup an email alias for the study, with which our participants could easily communicate will all researchers involved in the study. Furthermore we developed a set of online administration tools to allow us easily and efficiently communicate with our users. These online tools provided us with basic visual statistics for each user allowing researchers to gain quick insights into how each user was behaving throughout the study. The tool also provided the ability to send a personalized SMS message or email to the entire set of users, to subsets or groups

of deployment.

of users or indeed individual users. By building this tool we were able to cope with interacting with our user group in a more easy and efficient manner.

SMS as a Contextual Experience Sampling Framework

Overall we found that using SMS as a means of sampling our end-users was very successful. SMS is very popular, trusted communication technology for mobile phones used by billions of users to communicate with friends and family. What was interesting was the participants reactions to the use of SMS messaging. For example, even when our users had no information needs, if they received one of our SMS probes asking them about their needs, they opted to respond. In most cases they would respond and simply say "nothing" or "no information needs right now". SMS is normally considered a person-to-person technology and it appears that our users reacted to the SMS probes in exactly this manner, considering that they were sent from an individual and that a response was required.

Furthermore, given that the vast majority of mobile phones support SMS this meant that we did not have to develop any sophisticated native mobile applications nor did we have to restrict ourselves to one particular OS, one particular mobile platform/device or one particular subset of users. As such, we were able to attract a diverse range of participants. We believe that trusted technologies like SMS provide an excellent means of gathering valid mobile experience information in-situ from a diverse set of users.

Analysis of Large-Scale Datasets

We collected almost 12,000 SMS messages from 108 unique users over the 3 month period. Of these, over 9,000 messages have an associated diary entry. For the SMS that have diary entries we have additional data. For example, who the user was with, where they were located, if they satisfied their need, how they satisfied their need, etc. When designing the diary we tried to include a combination of predefined responses as well as freeform fields for more textual input. By doing so we were hoping to reduce the burden of filling in the diary entries for our user group. However, we were also hoping to ease the data analysis phase of our study.

Our study has resulted in a rich dataset of almost 12,000 data-points and beyond simple analyses, most of this data requires manual classification which is a time consuming task. In terms of classifying the SMS, we have hired two professionals for this task explicitly. We also built an interactive Web tool to assist in this classification. The tool displays the details of individual SMS messages along with the diary entires details for the SMS in question. The tools enables researchers to classify each SMS according to a set of categories we've devised. The tool also allows the researcher in question to mark an SMS as interesting, to bookmark the SMS if they would like to recall it later for discussion and there is also a comment facility, again used to facility discussions in regular brainstorming sessions within the team to discuss the data analysis. We are still in the data analysis phase and we have more work to do but to date these in-house tools have helped make the data analysis phase, in particular the manual classification part, more efficient.

CONCLUSIONS

In this paper we have described the design and deployment of a large-scale study of mobile information needs. The study ran for a period of 3 months, involved over 100 users and resulted in almost 12,000 data-points. The focus of our discussion was on our experiences in designing and deploying our user study, the lessons we learned and the challenges we faced in terms of deployment and in analyzing and understanding the large dataset we generated. We spent considerable time and effort in building the sampling algorithms for conducting this study and tools to help us engage with our users and classify the large data-set we have gathered. We believe these tools have great potential to be used in future studies of this nature. Overall the study was a successful case study in observing mobile users in-situ, however, we think that there is lots more work to be done in this space. We hope our paper contributes to the Research in the Large Workshop and provides a useful starting point for sparking interesting conversations in terms of how we can design and deploy mobile user studies on a large scale.

ACKNOWLEDGMENTS

This work is funded as part of a Marie Curie Intra European Fellowship for Career Development (IEF) award held by Karen Church.

REFERENCES

1. J. Brandt, N. Weiss, and S. R. Klemmer. txt 4 l8r: lowering the burden for diary studies under mobile conditions. In *Proceedings of CHI '07 extended abstracts*, pages 2303–2308. ACM, 2007.
2. M. Cherubini and N. Oliver. A refined experience sampling method to capture mobile user experience. In *Workshop of Mobile UX Research, held as part of CHI2009*, 2009.
3. K. Church and B. Smyth. Understanding the intent behind mobile information needs. In *Proceedings of IUI '09*, pages 247–256. ACM, 2009.
4. D. Dearman, M. Kellar, and K. N. Truong. An examination of daily information needs and sharing opportunities. In *Proceedings of CSCW'08*, CSCW '08, pages 679–688. ACM, 2008.
5. J. E. Fischer. Experience-sampling tools: a critical review. In *Mobile Living Labs 09: Methods and Tools for Evaluation in the Wild, part of MobileHCI 2009*. ACM, 2009.
6. T. Heimonen. Information needs and practices of active mobile internet users. In *Proceedings of Mobility '09*, pages 1–8. ACM, 2009.
7. S. E. Hormuth. The sampling of experiences in situ. 54(1):262293, 1986.
8. S. S. Intille, J. Rondoni, C. Kukla, I. Ancona, and L. Bao. A context-aware experience sampling tool. In *Proceedings of CHI '03 extended abstracts*, pages 972–973. ACM, 2003.
9. T. Sohn, K. A. Li, W. G. Griswold, and J. D. Hollan. A diary study of mobile information needs. In *Proceeding of CHI'08*, pages 433–442. ACM, 2008.